Hey, You!

the
CANNON

University of Toronto Engineering Society

ISSUE November 23, 1978

SHOOTING THE BREEZE

POWER FROM THE WIND

Bill Stewart

1. Introduction

The diminishing of our energy resources in the form of fossil fuels has forced us ta look towards other alternatives of producing energy and electricity. Wind power is one alternative worth considering. It is o relotively simple task to extract the power of the wind (compared to producing electricity using o nucleor reoctor), but most important, it requires na input of o fossil fuel ond expels no pollutants of ony kind.

One importont problem, at present, which is restricting the use of wind power is its cost. A few large scole wind generotors with outputs of the order of 100-200 kilowatts are currently in use supplying eclectricity ta the public. Some ore cast competitive with nucleor reactor plonts, but only those which are situoted in regions where the overoge wind speed is high (greater thon obout 30 km/hr).

In on orea such as Toronta where the average wind speed is obaut 17 km/hr, the cost af building ond mointoining o wind plont would greatly exceed the cast of building, maintaining, and supplying with fuel a nucleor plant with the same average power output. The maximum pawer delivered ta a wind turbine varies as the cube of the wind speed. Therefore, the cost of a plant will vary quite considerably fram one wind regime ta another, and in low wind speed regimes the wind plant becames economicolly unfeasible.

Another equolly importont problem is the large voriotions in autput power which result from wind speed voriotions. With other existing methods of producing electricity (such as nuclear, coal, ond water pawer) constont power output con be maintained for any desired length of time, olong with control af the power level. This is important if the electricity demonded by the public is to be supplied ond also to maintoin stability of the power network.

If wind pawer plonts are ta be used exclusively to supply fixed voltage, fixed frequency AC power, then there will hove ta be same type of medium for staring the energy. The medium would collect energy from the plont when the wind speeds ore high and deliver power ta the grid system when the wind speeds ore low. The cost of such o system would be high becouse the potentiol energy stored in the medium wauld have ta be converted ta a constont voltage, constont frequency AC voltage using, far example, an electrical inverter if the stored energy is electricol or an AC generator if the stored energy is water potential.

The maximum power delivered to o wind turbine varies os the cube of the wind speed.

Alternatively, a relotively small number of wind generotors con be connected directly to on existing power grid alreody supplied by constont speed synchronaus machines. The wind plant does not require a starage medium becouse the pawer grid octs as on "infinite bus" damping out ony tronsient fluctuotions supplied to it and determining the frequency ond voltage af the output of the generatar. This is the method af connection used at present with the lorge wind generators.

2. Wind Turbines

The two most common ànd most efficient types of wind turbines used ore the harizantal axis Stuart Mill and the verticol oxis Darrius Rotar.

A typicol exomple af o horizantal axis mill is the troditionol multi-blode windmill seen on many forms ond used to pump woter. A Stuort Mill is similor to this, but has only from twa to six blodes with three blodes being most common. The smoller Stuort Mills hove the generator situoted ot the top of the structure ond coupled directly to the turning rotar. For lorge mills, structural considerations moke it impossible to situote the generotor here. Instead, the generotor is placed ot the bose ond coupled to the rotor vio o geor box situated ot the top. For the sake of greoter efficiency, same systems deliver the rotor power to the generotor vio a hydroulic system.

A Dorrius Rotor looks similor to on egg beater with its oxis of rototion orient ed verticolly. The energy is coupled ta o generotor situoted ot the bose. The blode cross-sections ore oirfoil shoped ond when moving in an oir streom they give lift and produce the necessary tarque to turn the rotar.

The Darrius Rotor has severol advantages over the Stuart Mill. It is omnidirectional in receiving power fram the wind and therefar requires no aiming into the wind. The Stuart Mill, however, oreceives moximum power only when its blodes are focing the wind ond therefare same mechonism must be used to oim the wind rotar inta the wind (either o wind vone or a n electronic sensing device). Balancingof the blades is more criticol for the horizontol mill. Improperly bolonced blodes con result in violent mechonicol oscillotions occurring, especially in the larger mills. Most of the weight in the Darrius, nomely the generator, is situated near the base thus giving o low centre af gravity ond o relotively stoble support. A harizontol mill hos either its generotor or same sart af gearing apparatus at the top making it tap heavy and increasing the strain at its base.

The main advantage of the Stuart Mill aver the Darrius Ratar is that it is self starting. A Darrius Ratar will nat start from a standstill pasitian and therefare a matar is required to drive the mill up to its operating speed.

3. Wind Generation Schemes

Mony schemes exist ot present for converting wind power to electricity. Eoch is suited to delivering power to o porticular type of lood, whether it be on excited or infinite bus, an independent bus or just a single possive load. The term "excited bus" refers ta o bus which is olways

cont. an pg. 2

Programmable Calculators

Robert Anderson

The prices of calculotors has fallen in recent yeors to the point where now o programmoble calculotar can be bought for less thon $100, obaut the price of a good scientific colculator. This price drop hos eliminoted ony unfoir odvontoge ta those students with more money thon others For this reoson, severol students ond Foculty members hove indicated thot perhops it is time to reconsider the present bon ogoinst the use of progrommoble colculotors. Alreody, much deliberotion hos taken ploce, ond things ore storting to happen ta bring obout a portiol lifting of the bon.

While the details af events leding up to the present doy ore complicated, itis sufficient to soy thot there hos been much informol discussion on the subject. In oddition, orticles have oppeored in voriaus publicotions and discussion of the subject ot the October meeting of the Eng. soc. took place. As a result of oll thot, the fallowing motion wos presented ond passed at the November meeting af the Eng. Sac.:

"That this Society recommend that the Faculty policy on the use of programmable calculators be changed to permit the use of

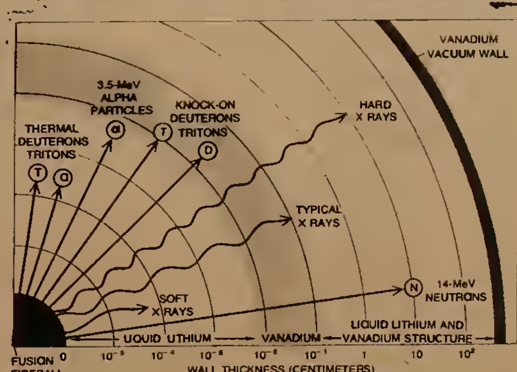
cant. on pg. 3

FUSION ENERGY

By G. Sinclair

cant. from last issue.

KMS experiments hove reached a yield of 5 x 10' neutrans per pellet, which is mony orders of magnitude too low ta achieve net energy bolance in the pellet. Energy bolonce will require neutron autputs of the order of 10^{14} to 10^{15} neutrans per pellet but this increase need not oll come from the more powerful losers. It is expected thot ignition will occur ot neutron autputs of the order at 10^{11} per pellet[8]. Ignition accurs when there is sufficient compression thot the energy of some of the olpho porticles produced will



FUSION RADIATIONS STRIKING FIRST WALL of a thermonuclear combustion chamber will penetrate to different depths depending on their energy. The wall must be designed accordingly to minimize damage to its structure. Roughly 70 percent of the energy released by the fusion of deuterium and tritium is carried by 14-MeV (million-electron-volt) neutrons, about 25 percent by charged particles (deuterons, tritons and alpha particles) and a few percent by X rays. Deuterons and tritons that carry only the normal fireball energy, equivalent to 10^8 degrees K., are called thermal. "Knock on" deuterons and tritons have been accelerated to energies about 100 times higher through collisions with neutrons in the fireball. The film of liquid lithium bathing the surface of the first wall will stop the softest X rays as well as all charged particles capable of aggregating into bubbles. Vanadium will probably be used as the structural material because it produces least radioactivity under neutron bombardment of any high-temperature material compatible with liquid lithium.

Wind Power

cont. from page 1

being supplied with power, usually by synchronous generators. An "infinite bus" is a special case of an excited bus. Such a bus will maintain its voltage unchanged as to magnitude, frequency and phase, independent of any loads or suppliers connected to it. Anylarge grid system can be considered a infinite bus because such grids are supplied by many synchronous generators. The term "independent bus" will be used to describe a bus which is supplied solely by a small number of wind generators.

Those schemes which deliver a constant voltage, constant frequency AC output will be considered. The frequency of the output will be assumed to be 60 Hz. Fig 3-1 shows diagramatically the various methods used and also considers some of the means of evergy conserving and storage.

There are two classes of generation schemes known as CSCF (constant speed, constant frequency) and VSCF (variable speed, constant frequency).

A CSCF scheme maintains a constant generator speed independent of wind speed. A synchronous machine connected to an infinite bus will maintain a constant speed determined by the line frequency of the bus. A synchronous machine connected to an independent bus or passive load will not maintain a constant speed, but its speed and therefore its output frequency will be determined by the speed of the wind. In order to make this generation scheme CSCF, some sort of mechanical transmission must be placed between the wind rotor and the generator which will drive the generator at constant speed independent of the speed of the wind rotor.

An induction machine, in order to generate, must derive excitation from the source it is delivering power to. Therefore, an induction machine will always be connected to an excited bus or usually an infinite bus. The speed of the generator varies from about 1.0 to 1.1 times the synchronous speed determined by the line frequency and because the variation is small, the scheme is still classified as CSCF.

Comparisons can be made between synchronous and induction machines as follows:

1) A synchronous machine can supply both active and reactive power controlled by varyng the rotor field curredt. An induction machine, however, always operates at a lagging power factor, and usually capacitors must be placed at its outputs in order to improve the power factor.

2) Since and induction machine derives its excitiation from the bus, therefore it requires no synchronisation ato the bus. A synchronous machine has its own excitiation and therefore equipment is needed to synchronise its output phase angle with the voltage phase angle of the bus.

3) Fluctuations (due to wind variations) introduced into the grid system are smaller when using an induction machine.

4) A synchronous machine will deliver power to all load types whereas an induction machine must deliver to an already excited bus. (A synchronous machine does however require external DC field excitation.)

A Darrius Rotor looks similar to an egg beater with its axis of rotation oriented vertically.

A VSCF scheme maintains a constant frequency output even though the generator speed may be changing.

One method of doing this is called AC-DC-AC Conversion. The output voltage of a synchronous generator is recitified and filtered to give a DC voltage. This DC voltage then drives an inverter which delivers a 60 Hz output. The output frequency is completely independent of the generator speed and the output voltage is only mildly dependent on the generator speed with variation depending on how well the rectified voltage is filtered. If a controlled rectifier (using thyristors) is used then the output voltage can be varied at will.

This generation scheme can be used to drive all load types. However, the rectifier and inverter make it costly and it may only be economical in areas which are isolated from a power grid system.

A second similar scheme employs a synchronous generator with a 60 Hz voltage applied at its field terminals. If the gevorator is run at a speed wm much greater than the angular frequency corresponding to 60 Hz then the output of the generator is a high frequency wave modulated by a 60 Hz wave. If this output is fed to a bridge rectifier, an inverter, and a filter as shown in Fig 3-2, the resulting output is a 60 Hz sine wave.

The same advantages and disadvantages exist with this scheme as with the AC-DC-AC scheme. The generator can drive independent buses and passive loads as long as a 60 Hz supply is present to power the field. (The output power of this supply would be small since it is only supplying field current.)

An AC commutator generator is similar to a DC machine but differs in that its field is excited by and AC voltage. The output is and AC voltage with frequency equal to the frequency of the field excitation and independent of the generator speed.

The generator can drive all load types as long as there is a source for the field excitation. There are no rectifiers or inverters thus reducing the cost and increasing the reliability of the system. The size of current AC commutator gevorators is limited to about 300 horsepower/pole. Fig 3-3 shows such a gevorator connected to an excited bus.

The last scheme makes use of an induction generator, specifically a Double Output Induction Generator (or wound rotor machine). Fig 3-4 shows its connection to an excited bus. In any single output induction generator, some of the power is lost in the rotor circuit. The double output generator of Fig 3-4 delivers this power back to the line via the rectifier and inverter. This "slip power" is small in comparison to the power being delivered at the stator output and therefore the rectifier and inverter have relatively small ratings and areless costly than those used in say the AC-DC-AC scheme.

If a controlled rectifier is used (employing thyristors) then the torque-speed characteristics of the generator can be varied. Sometimes, in regions where the wind varies considerably, one wishes to maintain the optimum wind speed to wind rotor speed ratio which operates the wind mill at maximum efficiency. A signal from a tachometer measuring rotor speed can be used to control the inverter and maintain this optimin speed ratio. The generation scheme then becomes VSCF.

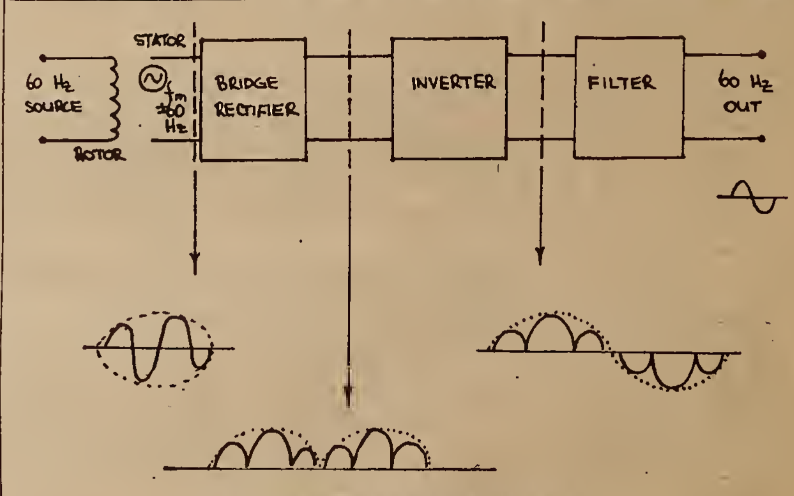


fig. 3-2 Modulated field generation scheme

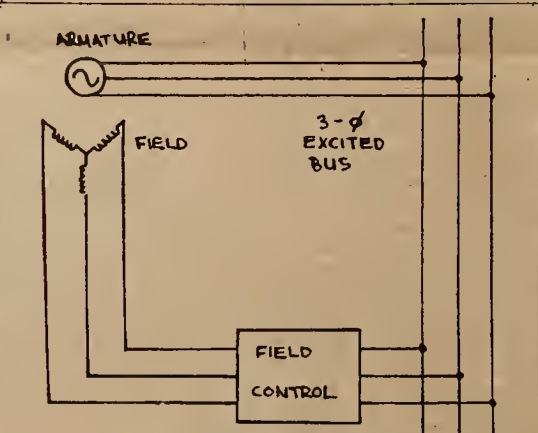


fig. 3-3 AC commutator generator

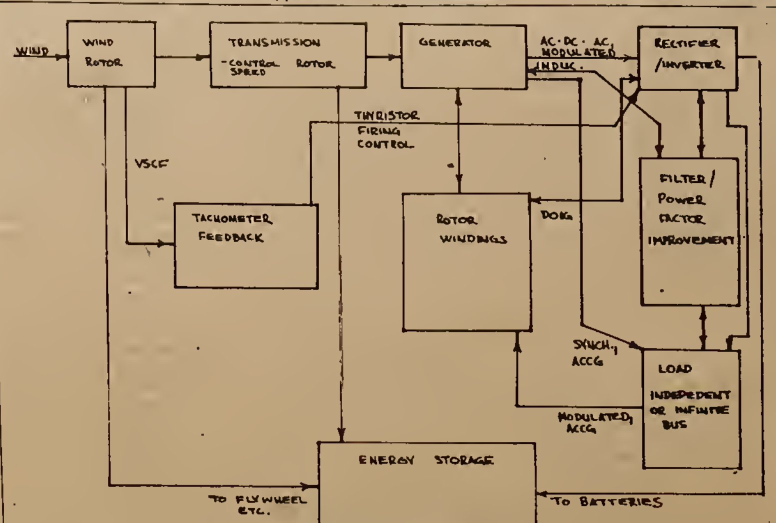


fig. 3-1 Wind power generating schemes

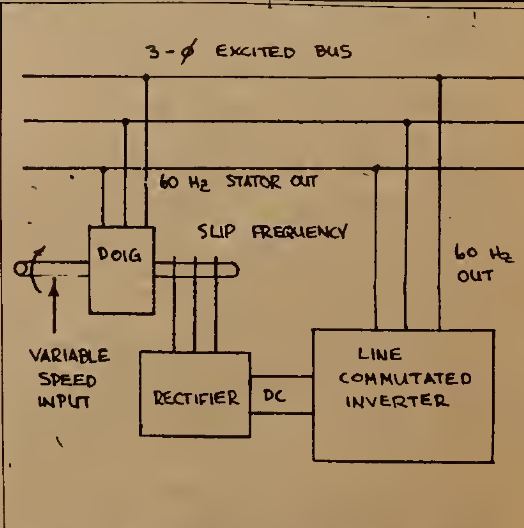


fig. 3-4 Double output induction generator (DOIG)

cont. from pg. 1

non-printing, silent, self-powered, non-continuous memory, key-programmable calculators on exams"

Motion Carried:
Those in favour-38
Those against-8
Abstentions-2

The motion is quite lengthy, but every word is there for a good reason. It is notable that this motion does not recommend the permitting of all kinds of programmable calculators; it does recommend permitting a specific class of programmable calculators which would offer the user no advantage over what is currently in use.

The criteria mentioned in the motion, which pin down exactly what kind of programmable calculator should be alowed require some explanation. First, a calculator should not have a printing capacity, as this may unfairly speed up program debugging or the aquisitian of results. In any case, a printing capability makes a calculator prohibitively expensive and thus not available to all. Second, any aid used in an examination should be silent and self-powered, for obvious reasons. Such criteria already apply to the use of non-programmable calculators presently allowed. Third, any aid which allows a student to bring in information other that that which he/she knows or has been specifically allowed to bring in, should be prohibited. A programmable calculator with any permanent memory capacity (suchas card programmable or continuous memory types) could provide a means of bringing in pre-programmed information, and thus cannot be allowed. The motion recommends only non-continuous memory, key-programmable calculators abe allowed, thus forcing all programming to be done in the exam through the keyboard only.

Several students have expressed fears that programmble calculators, if permitted, will be an unfair advantage for several reasons. Some feel that they would provide a computational advantage, but this is not the case for two reasons. First, the time to program and debug the calculator would be so large s to wipe out any advantage due to the bility to perform several steps at once. Second, all examinations must be set in such a way as to offer no disadvantage to those equipped with only slide rules; exams are for testing one's understanding, not one's calculating ablitiy.

Some students fear that there will be an enforcement problem: how will one be able to keep track of what is or is not allowed? It may surprise these people to hear that an enforcement problem exists even now! Only close examination can detemine whether a calculator is non-programmable at present. I feel that the enforcement problem is greatly over-stresses since few students will risk getting caught cheating and having it result in failure, suspension, or even expulsion

the recommendation to allow prog. calculators does not set a precedent. The APEO presently allows the use of any kind of calculator on their CCPE admission exams. I have heard that programmale calculators are presently in use on exams at Queen's and Waterloo, though I do not know if they restrict the type of calculator such as is proposed in the motion above.

It is important to note that this motion in no way encourages all students to go out and buy a programmable calculator; there is no need to do so far there is no advantage. Indeed, by not buying a programmable calculator, one may be able to get a more useful non-programmable calculator at the same price.

In conclusion, I would like to point out that this is merely a recommendation to the Faculty that it change its policy. From here, the issue must come before two standing committees of Faculty Council before it takes effect (assuming that it is passed. It likely will). it will not have to go before Faculty Council itself, for the issue is considered minor, but any decision to change the rules will not likely take effect until January. That means that nothing is changing before our exams in December; we will all have to use our non-programmable calculators until spring midterms.

Fusion Energy

cont. from page 1

contribute to the heating also. Improved designs of the pellets can be expected to ease the demands made on the laser. The power level in the KMS experiments has been less than ½ terawatt.

It is believed by KMS engineers that net energy balance in the pellet can be obtained with lower laser power and lower energy than are being predicted by others. They believe it would be possible to have a pilot fusion reactor operating by the mid 1980's assuming adequate funding were available. In view of the success of KMS in predicting and producing the first successful laser fusion in mid-1974, their statements need to be taken seriously.

The neodymium glass lasers used in experiments so far are not suitable for a commercial fusion reactor since the glass will not withstand the high repetition rates and the efficiency is too low. Repetition rates of the order of ten pellets per second and even higher are visualized as being needed. It is expected that suitable gas lasers will be developed to meet the requirements. The CO_2 laser is not likely to b e suitable as its wavelength (about ten times that of the neodymium laser) is too long for efficient coupling of energy to the small pellets. Neodymium lasers can only be used about once per half hour.

The Max Plank Institute in West Germany has made considerable progress in developing an Iodine laser which seems to have the basic characteristics needed for fusion. The wavelength is short (1.315 micrometers) and it is capable of high power. With proper cooling, it should be operable at high pulse rates. It has been suggested that the Asterix lasers developed at the Max Planck Institute could be incorporated in a system for laser fusion experiments with a persent capability of 0.5 terawatt and a potential for upgrading to 10 terawatts.'

Conversion of fusion energy to useful forms

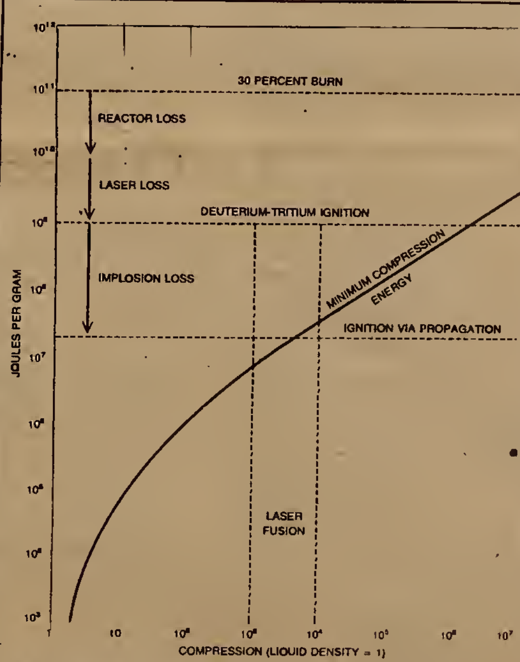
There is a conspicuous lack of effort being devoted at the present time to studying the question of how best to utilize the energy in the neutrons and olpha paricles. This is rather surprising since the method chosen for converting the fusion energy to more useful forms can make a major difference in the time scale involved for commercial utilization to be reached.

Practically all the current predictions of the time scale are based on the assumption that the fusion energy has be converted to thermal energy, by analogy with present nuclear power plants. Actually there are many different ways of using the fusion energy and the engineering problems needed to be solved differ markedly in their difficulty and complexity. The times required to solve these different problems vary over wide ranges.

In developing conceptual plans for Takomat reactors, it is assumed that the energy of the neutrons and alpha particles will be converted to thermal energy, usually by absorbing them in a liquid lithium blanket. Electrical energy is then to be produced by a conventional electric power plant. there are very severe design problems to be solved such as the damage to the first wall of the blanket from the neutrons and alpha particles. It is recognized that there does exist the possibility of direct conversion of the fusion energy to electric energy by MHD processes, but this will undoubtedly require extensive delveopment.

In laser fusion, the neutron source is essentially a point source instead of a ring source as in the Takamak, and this has advantages in devising methods for utilizing the energy. The neutron flux abeys an inverse-square law, which eases some of the design problems.

KMS Fusion is practically the only organization devoting substantial effort to the question of devising the best methods for energy conversion. Their present plan is to convert the fusion energy to Chemical energy rather than thermal, which appears to avoid many of the engineering problems plaguing the designers of the thermal . methods of conversion. The KMS proposal is to employ the fusion energy to produce the dissociation of water to yield cheap hydrogen.



FUEL COMPRESSION NEEDED FOR LASER FUSION is determined by anticipated efficiencies of the laser (10 percent), the implosion (5 percent) and the electric-generating system (effectively 10 percent, since not more than a third of the electric energy produced should be used to pump the laser). About 10^9 joules per gram is needed to ignite DT and about 10^{11} joules per gram is released if 30 percent of the fuel actually fuses. The energy gain of 100 is not large enough to accommodate the various efficiencies listed (.10 × .05 × .10 equals .0005, or .05 percent net efficiency). Fortunately in a highly compressed fuel pellet the fusion energy released by a small portion of the pellet serves to ignite the rest by radial propagation, thereby reducing the laser input required by a factor of about 100. Thus in the compression range between 10^3 and 10^4 the span between the minimum laser-input energy (about 2×10^7 joules per gram for the compression of relatively cold DT) and the energy output at 30 percent burn efficiency is large enough to make fusion power feasible.

Because of the stable structure of the water molecule, it is not feasible to separate water into hydrogen and oxygen by direcct irradiation. The yield is very small, with most of the energy appearing as heat. KMS Fusion have developed a two-stage process which effectively accomplishes the task with high efficiency. the first step is the radiolytic step, producing either hydrogen or oxygen from a suitable molecule, and in the second step, the other part of te molecule is used in a heat process with water to recover the original molecule plus oxygen or hydrogen. Thus there are two classes of nucleochemical cycles which can be used.

$$2\,HCl + \text{radiation} \longrightarrow H_2 + Cl_2$$

The hydrogen is extracted by conventional means, and the chlorine is then used in the following reaction:

$$Cl_2 + H_2O + \text{heat} \longrightarrow 2HCl + \tfrac{1}{2}O_2$$

The original molecule is thus recovered for recycling.

The result is to produce hydrogen and oxygen from water. If the original molecule (H Cl) is sensitive to radiation, the process can be quite efficient. In the other nucleo-chemical cycle, oxygen is produced in the radiolytic step, and hydrogen in the second step. There are many possible molecules which can be used in the radiolytic step, and the choice will depend on many factors. It is of interest to note that the above radiolytic step is the result of work done by Prof. D.A. Armstrong at the University of Calgary.

The KMS process promises to produce hydrogen at competitive cost, and there are many applicotions for it. KMS Fusion, with support from the Texas Gas Transmission Carp. of Owensboro, Ky., are aiming to produce substitute natural gas (SNG) for fuel purposes by adding carbon from a suitable source to make methane. The fundamental research on pellets at KMS is being supported by ERDA (Energy Research & Development Agency) of the U.S. Government. It is the goal of KMS to achieve commercial production of SNG by the late 1980's an achievement that will, of course, be dependent on the availability of funding.

It should be noted that the fission process cannot be used in the above mentioned nucleo-chemical process. About 80% of the energy in fission is carried by the radioactive fission fragments which must be tightly contained and are not suitable for use in direct irradiation methods for producing dissociation. In fusion, on the other hand, the energy is carried by neutrons and alpha particles, both of, which are quite useful for irradiation.

If it is desired to produce electric energy, there are several possibilities. For example, either the SNG or the hydrogen itself, can be burned to produce steam in a conventional power plant. Alternatively, fuel cells can be used, as hydrogen is the ideal fuel. ERDA has recently funded a project to build a 4.7 megawatt experimental fuel cell power plant. Larger fuel cells have already received some field testing.

Engineering Society

Coming Events

Thursday — Nov. 23

10:00 a.m. committee on Scholarships and Awards (GB167)
5:00 p.m. Eng Sci smoker (Physics Common room)

Friday — Nov. 24

10:00 a.m. Committee on Advanced Standing (GB167)
12:00 p.m. Common Room roamaround
5:00 p.m. The great Sci-Fi Toike makeup (Metro Library, 3rd flr.)

8:00 p.m. **F!RST YEAR ENGINEERING PUB NITE**
MED SCI LOBBY D.J. DANCE BEER NURSRS
S0 cents admission ANYONE AND EVERYONE WELCOME!

Saturday — Nov. 25

The following classes hold a special distinction: Geo. IV, Ind. IV., Met.IV IA,ID, Eng. Sci. Group 1. These classes have not had o Faculty Council representotive attend any of the three Engineering Society meetings since classes started in September. Faculty Council reps from the following classes hove ottended only one meeting: Geo.III, Met.III, Ind. II, Ele. II, IF, IG. All reps are reminded thot they cannot miss two consecutive meetings of the Engineering Society and retain their seot. Please attend metings or send a proxy.

Monday — Nov. 27

There will be an employment committee meeting on Mondoy November 27th 1978 at 5:10 p.m. in the Engineering Society Offices. anyone who is interested in joining this Committee who cannot attend, please leave your nome ond phone number in the social Committee Mailbox.

4:00 p.m. Committee on community Affairs (GB167)

Tuesday — Nov. 28

3:00 p.m. committee on Examinations (GB202)

Wednesday — Nov. 29

Thursday — Nov. 30

MECHANICAL SMOKER

5:00 p.m. Mechanical smoker. Guest speaker—topic: solar energy (Mech. common room, MC331) Everyone Welcome

Pizza ond refreshments available

NOTICE: TO MEMBERS OF THE ENGINEERING FOOTBALL TEAM

Anyone who still has equipment out is requested to bring it in as soon as possible. the othletic stores will be open on the tallowing days:
Thursday, Nov. 23 (12:00-2:00)
Friday, Nov. 24 (12:00-1:00)
Monday, Nov. 27 (12:00-1:00)
Tuesday, Nov. 28 (12:00-2:00)
Monday, Dec. 4 (12:00-1:00)
Tuesday, Dec. S (12:00-2:00)
Wednesday, Dec. 6 (12:00-1:00)

If you can't make it at any of these times please call Albert (S36-67B6) to make arrangements for a suitable time.

EXCITING CAREER IN ADVERTISING!

Engineering students
are invited to work as salesmen/women
for the Engineering Society Yearbook.

SKULE 78-79

on a straight commission basis.

All those interested, please attend a meeting in the Society Offices, 20 St. George St., 3rd Floor, on Monday, November 27, 1978, at 5 p.m.

Exciting Career in Sales

One of the better-known but least understood aspects of aur Eng. Soc. is the Engineering Stores. this little paragraph will, I hape, serve both as infarmation and invitation to any interested.

You all know the Stores is a pretty good place to get things at a decent price; and the phrase 'nan-profit' has probably been heord too. What this means is that the Stores tries to make only as much money as will cover operating costs. The most Importont of these costs is the salary of our full-time employee, June. Important because she handles not only over-the-counter sales, but also a significont part of the accounting and ordering process for the Stores.

The balance af accounting and ordering, as well as matters concerning changes in aperotians, are the responsibility of the Stores Manager. In conjunctian with the VP Admin. of the Eng. Soc., he is bosically respansible for all Stores activities. It is not on easy job to learn in a hurry, although once some experience is gained it is not too great a burden. Thus, in anticipation of next year, I would like to call NOW for anyone interested in gaining the valuable type of experience the Stares con offer to the Manager; a half-year's experience now could pay off when the September rush comes next year. In short, we want anyone who is considering the Manager' s job to come out now. ond gain a taste of what the job entails. If yau hodn't thought of it until now—why not?

Interested people can either leave o note with Jan at the Society Offices, or talk to me in the Stores ot lunch. Hope to see you soon!

Ken Smith
STORES MANAGER

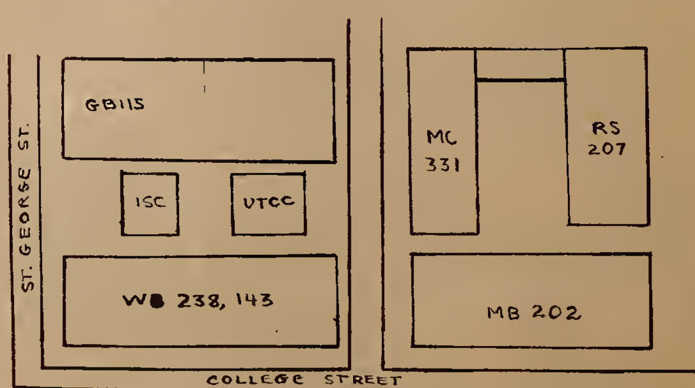
COMMON ROOM ROAMAROUND

Free Admission

Beer 50¢

Door Prizes

Food



GB115 Civ, Ele.
WB 238 Che, Eng Sci
WB143 MMS
MB202 Geo
RS207 Ind
MC331 Mec

Roamers who get to all six common rooms are eligible for a special grand prize. Start and pick up your "passport" at your own common room.

FRIDAY NOV. 24—12-3 p.m.

the CANNON 978-5377

Associate Editors:
Dano Williams,
Rob Pupulin,
Pete Ronkin

the CANNON is the journal of the Engineering Society. It is run by the students in the faculty of Engineering with the intent of providing the students in Engineering with an interesting and informative newspaper. All those who would like to help with your paper are welcome to. Submissions to the CANNON are also welcomed. They should be typed. The editors reserve the right to edit letters. The office of the CANNON is located on the Third Floor, Old metro Library, 20 St. George ST., Toronto, Ontorio, M5S 2E4.

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